A21L-05: A UAV-Based Fog Collector Design for Fine-Scale Aerobiological Sampling
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Airborne microbes are found throughout the troposphere and into the stratosphere. Knowing how the activity of airborne microorganisms can alter water, carbon, and other geochemical cycles is vital to a full understanding of local and global ecosystems. Just as on the land or in the ocean, atmospheric regions vary in habitability; the underlying geochemical, climatic, and ecological dynamics must be characterized at different scales to be effectively modeled. Most aerobiological studies have focused on a high level: 'How high are airborne microbes found?' and 'How far can they travel?' Most fog and cloud water studies collect from stationary ground stations (point) or along flight transects (1D). To complement and provide context for this data, we have designed a UAV-based modified fog and cloud water collector to retrieve 4D-resolved samples for biological and chemical analysis.

Our design uses a passive impacting collector hanging from a rigid rod suspended between two multi-rotor UAVs. The suspension design reduces the effect of turbulence and potential for contamination from the UAV downwash. The UAVs are currently modeled in a leader-follower configuration, taking advantage of recent advances in modular UAVs, UAV swarming, and flight planning.

The collector itself is a hydrophobic mesh. Materials including Tyvek, PTFE, nylon, and polypropylene monofilament fabricated via laser cutting, CNC knife, or 3D printing were characterized for droplet collection efficiency using a benchtop atomizer and particle counter. Because the meshes can be easily and inexpensively fabricated, a set can be pre-sterilized and brought to the field for 'hot swapping' to decrease cross-contamination between flight sessions or use as negative controls.

An onboard sensor and logging system records the time and location of each sample; when combined with flight tracking data, the samples can be resolved into a 4D volumetric map of the fog bank. Collected samples can be returned to the lab for a variety of analyses. Based on a review of existing flight studies, we have identified ion chromatography, metagenomic sequencing, cell staining and quantification, and ATP quantification as high-priority assays for implementation. Support for specific toxicology assays, such as methylmercury quantification, is also planned.

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